are added. The discussion of the various cases has been somewhat elaborated and the number of numerical exercises increased.

In the more theoretical part of the text there are many minor changes in the direction of brevity, which completely compensate for the additions and leave the number of pages unaltered.

There are no changes in that part of the book which deals with spherical trigonometry.

J. W. BRADSHAW.

An Introduction to the Mathematical Theory of Heat Conduction. By L. R. INGERSOLL and O. J. ZOBEL. Ginn and Co., Boston, 1913. 171 pages.

This is a handy little volume on the Fourier theory, intended partly as an introduction to the general methods of mathematical physics, or rather of those parts which are concerned with boundary-value problems in the integration of partial differential equations, partly to give an account of a number of special problems selected from the wide range of applications in physics, engineering, and geology, as the sub-title suggests. In view of this two-fold aim it is convenient to consider separately the treatment of the general theory and of the special problems.

As one would expect, the general mathematical material introduced coincides in the main with that contained in the more elementary portions of Fourier's own work, with more modern notation and some simplification of arrangement. It covers the more important of those cases of steady and variable distribution of temperature which are solvable by simple formulæ in elementary functions, by ordinary trigonometric series, or by Fourier's integral, either directly or by the device of extension of the realm of definition of a function such as to make certain boundary properties automatic. The problem of the sphere is also included, as solved for the case of spherical isothermals by generalized Fourier series.

In the more purely mathematical portions of the book there are a number of things which seem to call for criticism, a few of which may be named here. Certain infinite series used in leading up to Fourier's integral are not convergent, and the integral itself is written in some places so that the inner integral diverges. In the explanation of the formula of conduction the terms "plane" and "lamina" seem to be used as synonymous. In one place it is stated that the assumption of expansibility of a function into a sine-series is to be considered justified if values can be found for the coefficients. The term "general solution," from which special solutions are to be obtained by "substituting," is used, without any real need, in connection with partial differential equations, where the notion is practically useless and usually disagreeably vague unless taken in the unenlightening sense of the class of all solutions; then the comforting assurance is added that many cases can be solved by other methods, even when it would be "almost impossible" to obtain the general solution of the differential equation. These few instances illustrate an occasional looseness of expression which one could

fairly be expected to avoid without sacrificing the desired condensation of statement to which it seems to be due.

The physical basis of Fourier's fundamental equations is also treated concisely, but space is found for a sufficient discussion of numerical computations and of the various units of measure used. The dimensions assigned to quantity of heat are questionable. In one place it is suggested that conduction in the gross is really an aggregate effect of transfers of heat between molecules, which may occur with the velocity of sound; one wonders what basis there is for this. As in the mathematical portions, such purely incidental and probably misleading remarks, too brief to be both accurate and intelligible, might better have been omitted. Also it is stated that conduction depends only on differences of temperature, the actual temperature being immaterial, then, further on, data are given showing the variation of conductivity with temperature, and in another place it is stated that the use of the mean conductivity for the range of temperature in question gives an approximate solution which may be practically close enough. Here a little more coherence in the arrangement might have made this fundamental matter clearer, and also have served to give needed emphasis to the limitations of Fourier's assumptions.

The chief merit of the book will probably be found in the special problems which are presented as illustrations of the practical bearing and value of the analytic formulas. It is apparent that the main labor of the authors has been devoted to collecting, sifting, and by some novelties, adding to this remarkable list of special applications, whose titles fill a column in the index. They are all of some intrinsic interest, and are worked out briefly, but still far enough to secure some numerically definite conclusions. The extent and variety of this material make the book unique among the works on this subject known to the reviewer. Mention should also be made of the many splendid diagrams, illustrating the convergence of Fourier series, or giving various temperature-curves.

A. C. Lunn.

PROBLEMS AND SOLUTIONS.

B. F. Finkel, Chairman of the Committee.

PROBLEMS FOR SOLUTION.

Special Notice.—Please re-read the requests as to form of solutions on pp. 258–259 of the October issue. Unless these directions are observed by contributors, solutions must either be entirely rewritten by the committee or else rejected.

Managing Editor.

ALGEBRA.

397. Proposed by W. H. BUSSEY, University of Minnesota.

12 oxen are turned into a pasture of $3\frac{1}{3}$ acres and eat all the grass in 4 weeks so that the pasture is bare. 21 oxen are turned into a pasture of 10 acres and eat all the grass in 9 weeks. How many oxen will eat all the grass in a pasture of 24 acres in just exactly 18 weeks, it being assumed that the grass in all the pastures is at the same height when the oxen are turned in, and that the grass grows at a uniform rate?